"Turnout/Crossover Section for Railway Track"

The present invention relates to a turnout or crossover section of railway track and particularly but not exclusively relates to providing a temporary non-intrusive turnout or crossover section of a railway track.

Railway track requires to be maintained at regular intervals and in order to do this, the section of track that is being maintained must be cleared of trains. The track is normally closed to traffic often during no train periods and also out-with such periods thus causing train cancellations or trains being diverted to other routes for short or longer terms (blockades). In some instances, the trains are transferred from the track having the maintenance performed on it onto an adjacent track for a limited period (i.e. a few hours) and then back onto the original track. The trains are transferred onto the adjacent track by means of a crossover section of track and returned by means of

a second crossover. This is known in the art as "Single Line Working" (SLW). Conventionally, each of the crossover sections are intrusive, in that the section of track at which the crossover section is inserted must be cut; this involves cutting the existing rails of each railway track twice and installing the temporary crossover and also installing the switchgear along with providing an interface for signalling. However, such an intrusive crossover section is relatively expensive and requires a fairly long time to plan and to install, where the planning stage alone may take in the region of 2 years. The only other known alternative to solve this problem is to allow the trains to crossover at the nearest permanent crossover sections before and after the maintenance site but these may be many miles away and thus if repair or maintenance is required on only a few metres of track, trains may be forced to share one line of track for both directions (i.e. SLW) for many miles or may be extensively diverted onto alternative routes, thus leading to inefficiency and delays.

Those in the rail industry will also realise that there is a conflict between passengers who require train services during the daytime and freight trains which operate during the night and thus there is very little time to effect such repairs and maintenance. The overriding difficulty is access to the track for cost efficient maintenance.

It will be understood by those skilled in the art that a crossover comprises two individual turnouts, where a turnout can be used on its own or can be combined with another turnout to form a crossover.

In the context of this application, it should be noted that a non-intrusive crossover is one that does not pass through the rail to be crossed but instead crosses over the rail to be crossed.

According to a first aspect of the present invention there is provided a turnout for a railway track comprising a pair of spaced apart rails, the turnout comprising a raised track surface which is adapted to provide a path along which the wheels of a train can travel from one railway track to another, wherein the raised track surface comprises first and second portions and is arranged such that the wheels of the train are first raised by the first portion to a first rail crossing height and then lowered by the second portion to a height at a location between the pair of spaced apart rails of the railway track.

According to a first aspect of the present invention there is also provided a method of transferring a train from one railway track comprising a pair of spaced apart rails to a second railway track comprising a pair of spaced apart rails, the method comprising the steps of:-

providing a raised track surface having a first portion which comprises a raised portion and a second portion which comprises a lower portion

provided at a location between the spaced apart rails of the railway track, where the raised track surface is adapted to provide a path along which the wheels of the train can travel from the first to the second railway track;

driving the train along the first track and onto the raised track surface, wherein the first raised portion of is of a sufficient height such that the wheels of the train are arranged to clear the pair of spaced apart rails of the railway track; and

continuing to drive the train onto the second lower portion of the raised track surface.

Preferably, the turnout is further adapted such that the wheels of the train are first raised to a rail crossing height in order for a first wheel to cross a first rail, then lowered to a height at a location between the pair of spaced apart rails, then raised to the rail crossing height in order for a second wheel to cross the first rail, then preferably lowered to a height at a location between the first and second railway tracks.

The invention has the advantage that it permits short length Single Line Working without the need for relatively high track portions in between the spaced apart pair of rails of the railway track.

Preferably, a crossover comprises a pair of said turnouts.

Typically, the first and/or second non-intrusive crossover comprise a raised track surface, and preferably the raised track surface is provided with a supporting means to allow for passage of trains.

Typically, each of the first and second non-intrusive crossovers comprise a pair of turnouts, and preferably each pair of turnouts comprise a pair of rails which form the raised track surface.

Typically, each rail of the turnout further comprises at least a ramp surface, wherein, each ramp surface is preferably tapered from a short or no height end to a relatively tall height end. Most preferably, each ramp surface comprises a linear taper from the short or no height end to the relatively tall height end, and preferably the relatively tall height end is of the same height as that of the first rail crossing height. Typically, the relatively tall height end of the ramp surface is adjacent to an end of the raised track surface at its first rail crossing height, the two combining to provide a path along which the wheel is permitted to travel whilst maintaining a substantially equal distance between a pair of raised rails, which combined, form the raised track surface. Preferably, the ramp surface comprises a ramp for each rail of the railway track, where both ramps preferably incline simultaneously, typically avoiding differential levels, in relation to the respective rails.

At least a crossing portion of each rail of the raised track surface may comprise a slot formed therein, typically below a rail head portion, wherein the slot may be arranged to lie over or around the rail being crossed and the rail head portion is releasably fixed to the said rail being crossed.

At least a crossing portion of each rail of the raised track surface, which typically forms part of a crossing rail, or a switch rail preferably comprises a railhead portion arranged to lie over or around a supporting member which in turn is preferably arranged to lie over or around the rail being crossed. Preferably, the supporting member is arranged with its longitudinal axis being parallel to the rails of the parent rail. Preferably, the supporting member comprises at least an upper supporting member and at least a lower supporting member. Preferably, the upper supporting member is planar and more preferably, the upper surface of the upper supporting member is attached to the a lower surface of the crossing portion of the raised track. Preferably, at least another portion of the raised track surface, which is typically the ramp surface, is supported by the parent rail and a fixing means.

Typically, the upper supporting planar member is substantially wider than an existing rail of one of the first and second railway tracks.

Preferably, the upper supporting planar member is rectangular in shape, and more preferably, is in the form of a plate.

Preferably, a pair of guide means are provided along at least a portion of the upper supporting member's length. Preferably the guide means run parallel to the upper supporting member's longitudinal axis, and more preferably, project downwardly in order, in use, to straddle an existing rail of the first and second existing railway tracks.

Preferably, a pair of lower supporting members are provided at either side of at least a portion of the existing rail.

Preferably, the pair of lower supporting members combine to provide a substantially similar shape, width and position along the existing railway track as the upper supporting member, and are adapted to be releasably engaged thereto and more preferably, releasably fixed thereto, wherein the lower surface of the upper supporting planar member preferably lies on top of the uppermost surface of the lower supporting members. Most preferably, the upper supporting member is moveably coupled to at least one of the lower supporting members, typically by a hinge means. The hinge means has the advantage of permitting the upper supporting member to move between a first configuration in which the upper supporting member is arranged in a substantially horizontal plane and rests upon the pair of lower

supporting members over the existing rail of the railway track and a second configuration in which the upper supporting member is remote from the existing rail such that a train wheel may be driven along the existing rail in "normal running". Preferably, the upper supporting member is moved from the first to the second configuration by rotating the upper supporting member about the hinge means relative to the lower supporting member.

Alternatively, the lower supporting members combine to be longer and/or wider than the upper supporting member.

According to a second aspect of the present invention there is provided a turnout for a railway track comprising a pair of spaced apart rails, the turnout comprising a raised track surface which is adapted to provide a path along which the wheels of a train can travel from one railway track to another, wherein the raised track surface comprises a crossing rail portion adapted to cross over one of the spaced apart rails, the crossing rail portion being coupled to an upper supporting member which, in use, rests upon and is supported by at least one lower supporting member, characterised in that the upper and at least one lower supporting members are coupled to one another by a moveable mechanism.

Preferably, there are a pair of lower supporting members which typically combine to provide a substantially similar shape, width and position

along the existing railway track as the upper supporting member. Preferably, the upper supporting member comprises a substantially planar member and more preferably, the lower surface of the upper supporting planar member lies on top of the uppermost surface of the lower supporting members. Most preferably, the moveable mechanism comprises a hinge mechanism. The hinge mechanism is typically arranged to permit the upper supporting member to move between a first configuration in which the upper supporting member is arranged in a substantially horizontal plane and rests upon the pair of lower supporting members over the existing rail of the railway track and a second configuration in which the upper supporting member is remote from the existing rail such that a train wheel may be driven along the existing rail in "normal running". Preferably, the upper supporting member is moved from the first to the second configuration by rotating the upper supporting member about the hinge means relative to the lower supporting member.

Preferably, normal running of a train along the first and/or second existing railway track(s) may be allowed, where the train does not travel between the first and second existing railway tracks by moving or removing one or more sections of the crossover from engagement with the first and/or second existing railway tracks. Preferably, the one or more moveable or removable sections comprise at least a ramp, a first raised portion of the raised track surface, at least an upper supporting member,

and leaving in place the second lower portion of the raised track surface, and may include leaving in place at least one of the lower supporting members.

In a first embodiment, the second lower portion of the raised track surface is adapted to be at a height which is lower than the first raised portion. This has the advantage of preventing the second lower portion from protruding above the horizontal plane defined by the upper surface of the existing rails of the railway track by more than an acceptable level during normal running.

Typically, at least the crossing portion of the raised track surface, is formed on top of a rail head portion or more particularly when referring to the crossing rail, a raised crossover member, wherein the height of the raised crossover member at least equals, and is preferably greater than, the depth of a flange portion of the wheel of the train.

Typically, the raised track surface comprises a plurality of rail members, one or more of which comprise a curved radius away from one of the railway tracks towards the other railway track.

Preferably, the plurality of rail members combine to form a turnout having a substantially continuous rail surface and includes the following components:-

the said first portion which includes a ramp member adapted to raise the train wheel to the rail crossing height;

a curved radius rail adapted to urge the train away from one of the railway tracks towards the other railway track;

the second portion which includes a further ramp member adapted to lower the train wheel to a lower height at a location in between the pair of spaced apart rails of the railway track;

another first portion which includes a further ramp member to raise the train wheel from the lower height to a rail crossing height; and

a crossover rail adapted to allow the train to pass over an inner rail of the first existing railway track at the raised height.

The turnout may then further comprise another second portion which includes a further ramp member adapted to lower the train wheel to a lower height at a location in-between the inside rails of the first and second railway tracks;

Typically, at least a portion of the raised track surface, such as the substantially straight rail, is supported in the lateral and or vertical direction at a plurality of locations along its length by a support device. Preferably, the support device comprises a plurality of sleeper supports and more preferably comprises a plurality of pot sleeper arrangements.

Preferably, the one or more turnouts are temporary turnouts and more preferably are non-intrusive turnouts.

Typically, the pot sleeper arrangements comprise a body having an, in use, substantially planar upper surface onto which rails may be connected;

front and rear faces which extend downwardly at an angle to the upper surface, the faces having lower contact edges for contact with the ground; and

a pair of side ends which extend downwardly at an angle to the upper surface for a greater distance than the front and rear faces.

The pot sleeper arrangements have the advantage that the pair of side ends project, in use, into the ground thereby providing resistance against lateral (side to side) movement of the pot sleeper, whilst the main weight of the pot sleeper, rail and train is borne by the contact edges and/or the underside of the substantially planar upper surface.

Preferably, said lower contact edges having a greater surface area than the cross-sectional area of the front and rear sides.

Preferably, the front and rear faces combine with the upper surface to form an inverted 'U' shaped body, whilst the pair of side ends combine to close the longitudinal axis of the 'U' shaped body. Preferably, the body is hollow, where the hollow body may be partially or wholly filled with a filling material and more preferably, the contact edges are formed by lips which project either inwardly or outwardly from the body (preferably

outwardly) to provide a greater surface area to the body on the, in use, horizontal plane.

Typically, the upper surface is provided with a coupling mechanism to permit coupling of the pot sleeper to a rail. Preferably, a connection mechanism is provided to couple a first to a second respective pot sleeper, where the connection mechanism may include a substantially rigid member which extends therebetween. Typically, the substantially rigid member may be arranged to pass underneath the rails of the existing railway track.

Preferably, the pot sleepers are driven into ground ballast by a mechanical means which may be a vibrating mechanism means. Typically, further ballast or other material may be inserted into the hollow body to maintain/increase the height of the pot sleeper, in use.

According to a third aspect of the present invention there is provided a turnout for a railway track comprising a pair of spaced apart rails, the turnout comprising a raised track surface which is adapted to provide a path along which the wheels of a train can travel from one railway track to another, wherein the raised track surface comprises a ramp member to permit a wheel of a train to enter the raised track surface, the ramp member comprising:-

a fixing mechanism to releasably secure the ramp member to one of the spaced apart rails;

an upper ramp surface which in use provides a rail surface for a tread of the wheel to traverse; and

a lead-in portion which is arranged at one side of the said one of the spaced apart rails, wherein the lead-in portion comprises an upper rail surface which, in use, is inclined at an angle to the horizontal axis and which provides a rail surface for a portion of the tread to traverse.

Preferably, the upper rail surface of the lead-in portion is arranged to lie at one side of the said one of the spaced apart rails and has an outermost end which is arranged to be located at a height lower than the upper rail surface of the said one of the spaced apart rails and an innermost end which merges into the rest of the upper rail surface of the ramp member.

Preferably, the portion of the ramp member which merges from the lead-in portion to the rest of the upper rail surface is also arranged at an angle between the transverse direction of the rail surface and the longitudinal axis of the rail surface.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a plan view of temporary non-intrusive turnout as described in our co-pending International (PCT) Application No PCT/GB03/03555;

Fig. 2 is a plan view of a portion of the turnout of Fig. 1 highlighted as detail 1;

Fig. 3a is a cross-sectional view across section B-B of Fig. 2;

Fig. 3b is a side view of a portion of the turnout shown in the direction of A-A of Fig. 2;

Fig. 4 is a close up view of a G-clamp indicated in Fig. 6 as detail 2;

Fig. 5 is a close up view of a G-clamp of Fig. 7a indicated as detail 3;

Fig. 6 is a cross-sectional view across section C-C of Fig. 1;

Fig. 7a is a cross-sectional view across section D-D of Fig. 1;

Fig. 7b is a side view of the portion of the turnout shown in Fig. 7a;

Fig. 8 is a cross-sectional view across section E-E of Fig. 1;

Fig. 9a is a close up plan view of the portion of the turnout indicated in Fig. 1 as detail 4;

Fig. 9b is a cross-sectional view across section F-F of Fig. 9a;

Fig. 10 is a perspective view of a scale model of a temporary non-intrusive turnout, substantially identical to that shown in Fig. 1 during installation;

Fig. 11 is a perspective view of the turnout section of Fig. 10 further on during construction;

Fig. 12 is a perspective view of the turnout section of Fig. 11 further on during construction;

Fig. 13 is a perspective view of the turnout section of Fig. 12 further on during construction;

Fig. 14 is a plan view of one end of the turnout section of Fig. 13;

Fig. 15 is a perspective view of a model representing a train as it enters the turnout section of Fig. 14;

Fig. 16 is a perspective view of the model of Fig. 15 as it progresses through the turnout section;

Fig. 17 is a perspective view of the model of Fig. 16 as it progresses further through the turnout section;

Fig. 18 is a perspective view of the model of Fig. 17 as it nears the end of the turnout section;

Fig. 19a is a plan view of an alternative switch rail to that shown in Fig. 1, where the switch rail is mounted on a support plate;

Fig. 19b is a cross-sectional view of the switch rail of Fig. 19a;

Fig. 19c is a plan view of the switch rail and support plate of Fig. 19a;

Fig. 19d is a side view of the support plate of Fig. 19a;

Fig. 19e is a side view of an end of the switch rail of Fig. 19a;

Fig. 19f is an end view of the end of the switch rail of Fig. 19e;

Fig. 20a is a plan view of an alternative embodiment of crossing rail to that shown in Fig. 1;

Fig. 20b is a cross-sectional view of the crossing rail of Fig. 20a;

Fig. 20c is a side view of an end of the crossing rail of Fig. 20a;

Fig. 20d is an end view of the end of the crossing rail of Fig. 20c;

Fig. 21a is a plan view of the crossing rail of Fig. 20a as it crosses an existing rail of a railway track;

Fig. 21b is a cross-sectional view of the crossing rail taken through the line A-A of Fig. 21a;

Fig. 21c is a plan view of the crossing rail of Fig. 21a without the existing rail for clarity;

Fig. 21d is a side view of the crossing rail of Fig. 21c;

Figs. 22a, b, c and d are side views of possible/optional gutt rail deflecting means for use with a gutt rail of the turnout of Fig. 1;

Fig. 23a is a plan view of level crossing support members for supporting the switch rail of Fig. 19a;

Fig. 23b is a cross-sectional view of level crossing support members of Fig. 23a;

Fig. 23c is a detailed plan view of level crossing support members for supporting the crossing rails of the turnout of Fig. 1;

Fig. 23d is a cross-sectional view of the level crossing support members and the crossing rail of Fig. 23c;

Fig. 23e is an plan overview showing the position of the level crossing support members of Fig. 23c within the crossover;

Fig. 24a is a perspective view of a further turnout as described in our co-pending International (PCT) Application No PCT/GB03/03555;

Fig. 24b is a plan view of the switch rail and ramp rails and associated level crossing support members of the turnout of Fig. 24a;

Fig. 24c is a perspective view of the temporary turnout of Fig. 24a, also showing an arrangement of pot sleepers as described in our co-pending International (PCT) Application No PCT/GB03/03555;

Fig. 25a is a side view of the ramp rails leading onto the switch rails of the turnout of Fig. 24a;

Fig. 25b is side view showing one of the train wheels mid-way up the ramp rail of Fig. 25a;

Fig. 26 is a perspective view showing the ramp rail and clamping mechanism;

Figs. 27a and 28a are perspective view photographs showing the crossing rail of Fig. 24a during installation;

Figs. 29a, b, c, d are end view photographs showing the train wheels passing a portion of the support members of Fig. 24b during normal running;

Fig. 29a and 29f show the support members and gutt rails of Fig. 29a in position during normal running;

Fig. 29g is a perspective view showing the support members of Fig. 29a prior to installation;

Fig. 30 is a perspective view showing the train passing over the crossing rails of Fig. 29a, whilst clearing the main tracks;

Fig. 31a and 31b are perspective view photographs taken during installation of the ramp rails and switch rails of Fig. 29a;

Fig. 32a is a plan view showing the layout of the pot sleepers of Fig. 24c;

Fig. 32b is a plane view showing two pot sleeper arrangements of Fig. 24c connected by a rigid frame;

Fig. 32c shows an end, side, and plan view of the pot sleeper arrangement of Fig. 24c;

Fig. 33a is a perspective view showing the pot sleeper and rigid frame arrangements of Fig. 32b in their operational position;

Fig. 33b is a perspective view of the pot sleeper arrangement of Fig. 24c with a sample rail section fixed thereto;

Fig. 34a is side view of the pot sleeper arrangement of Fig. 24c with a sample rail section fixed thereto;

Fig. 34b is a perspective view showing the pot sleeper arrangement and switch rail of Fig. 24c in their operational positions;

Fig. 35a and 35b are perspective view photographs showing the layout of the pot sleeper arrangements of Fig. 24c;

Fig. 36a is a plan view of a crossover in accordance with the first and second aspects of the present invention, where the crossover rail is mounted on a support plate which is in a first configuration;

Fig. 36b is a plan view of the crossover rail and support plate of Fig. 36a;

Fig. 36c is a plan view of the crossover rail of Fig. 36a;

Fig. 36d is a cross-sectional view of the crossover rail of Fig. 36a;

Fig. 36e is a cross-sectional view of the crossover rail of Fig. 36a with the support plate and crossover rail hinged to one side in a second configuration;

Fig. 36f is an end view of the end of the crossover rail of Fig. 36a;

Fig. 37a is a plan view of a switch rail in accordance with the first and second aspect of the present invention, where the switch rail is mounted on a support plate which is in a first configuration;

Fig. 37b is a plan view of the switch rail and support plate of Fig. 37a;

Fig. 37c is a plan view of the switch rail of Fig. 37a;

Fig. 37d is a cross-sectional view of the switch rail of Fig. 37a;

Fig. 37e is a cross-sectional view of the crossover rail of Fig. 37a with the support plate and switch rail hinged to one side in a second configuration;

Fig. 38a is a plan view of a temporary non-intrusive turnout in accordance with a first aspect of the present invention;

Fig. 38b is a schematic diagram illustrating the height variation along the length of the temporary non-intrusive turnout of Fig. 38a;

Fig. 39a is transverse view of a ramp in accordance with the first and third aspect of the present invention;

Fig. 39b is a plan view of the ramp of Fig. 39a;

Fig. 39c is a cross sectional view illustrating train wheels being supported by the ramps of Fig. 39a; and

Fig. 39d is a more detailed cross sectional view of the ramps of Fig. 39c.

Fig. 1 shows a non-intrusive turnout generally indicated as 10.. It will be appreciated by the reader that two spaced apart non-intrusive turnouts 10 are utilised on a section of track to provide a non-intrusive crossover.

As shown in Fig. 1, the temporary non-intrusive turnout 10 links a south bound rail track 12 and a north bound rail track 14, such that a train (not shown) which has already been transferred from the south bound rail track 12 to travel south along the north bound rail track 14 can be transferred back onto the south bound rail track 12. In this manner, the portion of the south bound rail track 12' can be repaired/maintained. The skilled reader will realise that other routes of transfer could be installed and adopted.

The temporary non-intrusive turnout 10 comprises a number of components which will now be described.

The non-intrusive turnout 10 comprises a pair of turnout tracks 16, 18 and a plurality of temporary sleepers 20. For ease of reference, the turnout

track 16 will be referred to as the left hand turnout track 16 and the turnout track 18 will be referred to as the right hand turnout track 18.

The left hand turnout track 16 comprises, from the left hand end of Fig. 1, a ramp rail 22L. The uppermost portion of the ramp rail 22L is wedge shaped, with the uppermost surface tapering linearly from its left most end which has a height of 0mm up to its right most end which has a height of approximately 50mm and this linear tapering can be best seen in Figs. 7B, 25A and 25B which shows that the ramp rail 22 has a sufficient length, in the region of 1700mm, such that the angle of tapering is relatively gradual. The ramp rail 22L is coupled to the north bound left hand rail track 14L by means of a G-clamp mechanism 32 as shown in Fig. 5; it should be noted however that other types of clamp mechanisms could be utilised. The ramp rail 22 comprises a head portion 51 which rests on top of the upper flat surface of the rail track 12, 14. A neck portion 53 extends downwardly from the inner most edge of the head portion 51, where the neck portion 53 is shaped to substantially match the shape of the inside face of the rail track 12, 14.

The G-clamp mechanism 32 comprises a G-shaped clamp 34, one end of which surrounds and is compressed against, the opposite upstanding face of the rail track 12, 14 to the neck portion 53. A vice 36 extends toward the neck portion 53 of the ramp rail 22 from the other end of the G-shaped clamp 34, such

that the vice 36 can be forced or urged into secure connection with the neck portion 53. Preferably, the vice 36 is of a type that can be readily assembled and disassembled in a short amount of time.

Following on from the ramp rail 22L from left to right, the left hand turnout track 16 next comprises a switch rail 24L, the left hand most end of which is arranged to butt against the right hand most end of the ramp rail 22L, as shown in Fig. 7b. As shown in Fig. 6, the switch rail 24L, 24R comprises a respective head portion 55L, 55R and the switch rail 24L, 24R is inwardly curved along its length, toward the south bound rail track 12 and thus away from the north bound rail track 14. In other words, the end of the switch rail 24L adjacent to the ramp rail 22L is located directly above the north bound rail track 14L whilst the opposite end of the switch rail 24L is displaced from the north bound rail track 14L. Nevertheless, the head portion 55L comprises a linear height of approximately 50mm arranged horizontally along its length. The switch rail 24L also comprises a neck portion 57L. Conveniently, and as shown in Fig. 4, the neck portion 57L may have a slot formed in it at the end of the switch rail 24L closest to the ramp rail 22L, such that the upper most portion of the north bound rail track 14L can protrude inwardly through said slot. Alternatively, the slot may be omitted, with the neck portion 57L following the shape of the inside face of the north bound rail track 14L. The switch

rail 24L is secured in a releasable fashion to the north bound rail track 14L by means of a G-clamp mechanism 62 which operates in a similar fashion to the G-clamp mechanism 32 of Fig. 5. The G-clamp mechanism 62 as shown in Fig. 4 comprises a similar G-shaped clamp 64 and a vice 66. The switch rail 24L is supported at its middle and right hand most end from underneath by the G-clamp mechanism 62 and temporary sleepers 20. It should be noted that the term "inside face" is used in the sense that it is the face that the respective turnout track 16, 18 is being turned away from.

Following on from the switch rail 24L from left to right, the left hand turnout track 16 next comprises a gutt rail 26L. The gutt rail 26L has an I-shaped cross-section which is broadly similar to the I-shaped cross-section of a normal rail track such as 12, 14. The gutt rail 26L continues to bend at approximately the same radius as the bend radius of the switch rail 24L. The clamping mechanism of the gutt rail 26L to the north bound rail track 14L is similar to that as shown in Fig. 8 which will be described subsequently. Again, the gutt rail 26L is supported from underneath by the clamping mechanism and temporary sleepers 20 to have its upper flat horizontal surface to be approximately 50mm above the south bound 12 and hence north bound 14 rail tracks.

Up until this point, the right hand turnout track 18 substantially mirrors that of the left hand turnout

track 16, since the right hand turnout track 18 comprises, from left to right in Fig. 1, a ramp rail 22R, a switch rail 24R and a gutt rail 26R.

The left hand turnout track 16 from left to right after the gutt rail 26L comprises a straight rail 28L which thus has no bend radius and which once again is supported by the temporary sleepers 20 to have its upper flat horizontal surface to be approximately 50mm above the south bound 12 and hence north bound 14 rail tracks.

Following immediately on from the straight rail 28L, the left hand turnout track 16 comprises a crossing rail 30L which is broadly similar to the crossing rail 30R which will be described subsequently.

Immediately following on from the gutt rail 26R, the right hand turnout track 18 comprises a crossing rail 30R which is shown in more detail in Fig. 2 and Figs. 3A and 3B. The crossing rail 30R comprises a substantially I-shaped cross-section toward and at both its ends which is substantially the same I-shaped cross-section as the existing south bound 12 and north bound 14 rail track. Thus, towards and at its ends, the crossing rail 30R comprises a head portion 59 and a neck portion 61. However, a slot or gap 31 is provided along a portion of the length of the crossing rail 30R about the mid point of the crossing rail 30R such that there is no neck portion 61 in the region of the slot 31 as shown most clearly in Fig. 3B. The crossing rail 30R is

arranged to lie across the north bound rail track 14L such that the north bound rail track 14L lies within the slot 31. Accordingly, since the crossing rail 30R is again supported from underneath by the temporary sleepers 20 to have its head portion 59 with a height of approximately 50mm and since the crossing rail 30R is arranged to be horizontal, the upper most surface of the crossing rail 30R is approximately 50mm higher than the upper most surface of the south bound 12 and north bound 14 rail tracks.

The right hand turnout track 18 next comprises from left to right and immediately after the crossing rail 30R, a straight rail 28R which is substantially identical in function and arrangement to the straight rail 28L previously described. Similarly, the crossing rail 30L is substantially identical to the crossing rail 30R in function and arrangement except that the crossing rail 30L crosses over the south bound rail track 12R.

The left hand turnout track 16 follows on from left to right after the crossing rail 30L with a gutt rail 42L which is followed by a switch rail 44L which is in turn followed by a ramp rail 46L which are respectively substantially identical to the gutt rails 26L, switch rail 24L and ramp rail 22L in function and arrangement.

The right hand turnout track 18 follows on from the straight rail 28R from left to right with a gutt

rail 22R which is followed by a switch rail 44R which is in turn followed by a ramp rail 46R which are respectively substantially identical in function and arrangement to the gutt rail 26R, the switch rail 24R and the ramp rail 22R.

As shown in Fig. 8, the gutt rails 42L, 42R (and thus the gutt rails 26L, 26R) are clamped to the south bound rail tracks 12L, 12R by means of a J block arrangement 68L, 68R and a lengthened G-clamp mechanism 70L, 70R. The J block arrangement 68L and G-clamp mechanism 70L will now be described, but those skilled in the art will realise that the J block arrangement 68R and G-clamp mechanism 70R are substantially identical to the J block arrangement 68L and G-clamp mechanism 70L except that they are rotated through 180°. The gutt rail 42L is spaced apart from the south bound rail track 12L by means of the J block arrangement 68L which is preferably formed from any hard material that is shaped to fit into the heart of the rail to maintain a set distance between the rails. As shown in Fig. 8, the J block arrangement 68L is arranged such that it not only spaces the gutt rail 42L horizontally apart from the south bound rail track 12L but it also spaces them vertically apart, such that the upper most horizontally arranged surface of the gutt rail 42L is approximately 50mm vertically above the upper most horizontally arranged surface of the south bound rail track 12L. The G-clamp mechanism 70L clamps the gutt rail 42L to the south bound rail track 12L via the J block arrangement 68L and the G-

clamp mechanism 70L once again comprises a vice 76L or a bolted fixing through the rail 12L, 42L and J block arrangement 68L or similar arrangement.

It should be noted that, as shown in Fig. 9A, the left hand 16 and right hand 18 turnout tracks may be provided with a pot sleeper arrangement 80, where the two pot sleeper arrangements 80L, 80R are coupled to one another via a rigid frame 82L, 82R, where the rigid frame 82L, 82R may be provided in two halves, 82L, 82R which are coupled to one another at their outer most ends via a suitable fixing means 84 such as nuts and bolts (not shown). Thus, the pot sleeper arrangement 80L, 80R can be used either to replace the temporary sleepers 20 (as shown in Figs. 32A and 33A) or could be provided on top of an in-situ or existing timber sleeper, in order to provide increased rigidity to the non-intrusive temporary turnout 10.

The pot sleeper arrangement 80 is shown in more detail in Figs. 33B and 34A with a sample rail section 86 fixed in position. The beam section 84 of the pot sleeper 80 has a hollow, inverted U-shaped cross section which is toed out at the lowermost end of each side of the inverted, U-shape to form lips 88. End plates 90 are attached to each end of the beam section 84 such that each end plate 90 protrudes vertically downward past the lips 88, the downward projection typically being in the region of 100mm. The sample rail section 86 is connected to the beam section 84 by conventional

'Pandrol' clips 92 which are known widely in the railway industry.

When the pot sleepers 80 are in position, the end plates 90 project into the ballast or stones(not shown in Fig. 33B) until the lips 88 are level with the ballast (not shown). This projection of the plates 90 provides increased lateral stability to the pot sleepers 80 in both the longitudinal and perpendicular directions with respect to the main axis of the pot sleepers 80, whilst keeping the mass of the pot sleeper arrangement 80 to a minimum. The lips 88 also create a larger surface area or footprint for the pot sleeper 80 which avoids it sinking into the ballast (not shown) beyond a satisfactory depth when a load is placed on the pot sleeper 80 (i.e. during the passing of a train 5).

Fig. 10 shows a scale model of a non-intrusive turnout 10 part way through construction; it should be noted however that the scale model shown in Fig. 10 omits the straight rails 28L, 28R and also the switch rails 44L, 44R but it is envisaged that the straight 28L, 28R and switch 44L, 44R rails would be used in a full size rail track 12, 14.

Fig. 10 shows that a couple of temporary sleepers 20 have been laid, and the gutt rails 42L, 42R have been secured to the temporary sleepers 20 and also secured to the south bound track 12L, 12R. It should also be noted that the gutt rails 42R are in essence longer versions of the switch rails 44L, 44R

in the model shown in Fig. 10 through Fig. 18. The crossover rail 30L has also been installed such that it crosses over the south bound rail track 12R. Fig. 11 shows that the gutt/switch rail 26L has been installed next and is followed by installation of the gutt/switch rail 26R in Fig. 12 and is followed by the crossover rail 30R as shown in Fig. 13. Thereafter, the ramp rails 22L, 22R are secured to the respective north bound rail tracks 14L, 14R.

A model of a train 5 is shown in Fig. 15 as having travelled south along the north bound rail track 14 and having mounted the ramp rails 22L, 22R. It is important to note that the ramp rails 22L, 22R raise the wheels of the train (not shown) and thus the model train 5 by an amount sufficient such that the flanged part of the wheel is just vertically above the height of the rest of the normal track 14L, 14R. Thus, and as shown in Fig. 16, when the model train 5 moves onto the crossing rails 30L, 30R, the left hand 16 and right hand 18 turnout tracks are of a sufficient height such that the flanged part of the wheel 7, which normally acts to keep the model train 5 and thus full size trains on the tracks, is able to clear the north bound rail track 14L and then the south bound rail track 12R. The model 5 is shown in Fig. 17 as continuing through the non-intrusive temporary turnout 10 until it reaches the position shown in Fig. 18 which shows the model 5 about to travel down the ramp rails 46L, 46R and then onward as per normal south along the south bound rail track 12.

The non-intrusive turnout 10 previously described herein has the great advantage that the rail tracks 12R and 14L do not require to be cut which would be normal if a conventional intrusive temporary turnout was to be inserted in to the tracks 12, 14. Furthermore, those skilled in the art will appreciate that, if a train requires to pass through the non-intrusive temporary turnout 10 without actually crossing over from one track 12 onto another track 14, the ramp rails 22 or 46 as required can be removed along with the respective switch rails 24 or 44 and crossing rail 30L or 30R and as such the train will be able to bypass the non-intrusive temporary turnout 10.

An alternative non-intrusive turnout will now be described with reference to Figs. 19 to 35.

The sequence of rail components length wise along the track of the turnout of Figs. 19 to 35 is the same as that for the non-intrusive turnout(Fig. 1) i.e. from the left hand end of the left hand turnout track 16, a pair of ramp rails 21, 22 followed by a pair of switch rails 23, 24 followed by a pair of gutt rails 25, 26, followed by a pair of crossing rails 29, 30 etc.

The ramp rails 21, 22 and the means of connecting the ramp rails 21, 22 (G-clamp mechanism 32, represented by 32 in Fig. 26) in this alternative are broadly similar to that of the previous non-

intrusive turnout, and thus require no further description.

Following on from the ramp rails 21, 22, Figs 19A and B along with Figs. 24A, B , C) shows a pair of switch rail units generally designated 100 comprising a switch rail head 50, planar member or plate 38, guide means 60 in the form of downwardly projecting guide flanges 60, a pair of supporting members 40, end plate 72, and support connecting means 48 in the form of clips 48.

The switch rail head 50 essentially takes the form of an upper portion of an I-shaped rail section (shown during installation of the apparatus in Figs. 31A and B), and extends between one end of the switch rail unit 100 and the other. The switch rail head 50 is inwardly curved along its length toward the south bound rail track 12 and thus away from the north bound rail track 14, in a broadly similar manner to that previously described (Fig. 1).

The planar member or plate 38 is rectangular in dimension and is permanently attached to the switch rail head 50 by any suitable means during manufacture such as welding or moulding etc. The plate 38 may or may not extend along the full length of the switch rail unit 100; in the latter case, the switch rail head 50 will overhang the plate member 38. This is best seen in Figs. 27A and 28A.

The pair of guide flanges 60 project downwardly from the plate 38 and run parallel to the existing north bound track 14 along the entire length of the switch rail unit 100 and are displaced from the centreline or the plate 38 by an amount which allows the inner track of the existing north bound track 14 to fit closely between the pair of guide flanges 60. The skilled reader will realise that the guide flanges 60 may only be present at the extreme ends of the plate 38.

Each supporting member 40 may be a wooden timber and has a cross sectional shape which allows them to be placed underneath the plate 38 and close around the inner and outer neck portions of the existing rail. The lower surface of each supporting member 40 together may also be adapted, during manufacture or upon installation, to match the contours of a variety of standard railway sleepers. The pair of supporting members 40 are of a length, width and position, substantially similar to that of the plate 38, though it will be appreciated that longer and or wider supporting members may be preferable depending upon the individual situation parameters, for example the alignment and or size of the gaps between sleepers.

The clips 48 releasably attach the pair of supporting members 40 to the plate 38, and are designed such that they will hold the supporting members 40 firmly against the planar member 38 in

the vertical direction, and against the existing rail in the lateral direction.

The end plate 72 protrudes vertically downward from the overhang created by the switch rail head 50 and butts against the end of the inner supporting member 40.

It will be appreciated by the reader that in this embodiment the supporting members 40 may be left in position during normal running of the railway track (as shown in Figs. 29A, B, C, D, E and F); that is when no transfer of trains between one railway track and another is required, so that there is no crossover of a train 5 travelling on either north bound track 14 or south bound track 12. Alternatively the supporting members 40 may be placed to one side ready for installation as shown in Fig. 29G. Therefore the switch rail head 50 and planar member 38 may be installed and removed with relative ease and in a relatively short amount of time as desired.

Following on from the switch rail unit 100 the turnout next comprises a pair of gutt rails 25, 26. The gutt rails 25, 26 are broadly similar to that previously described, and thus require no further description.

Following on from the gutt rails 25, 26, the turnout next comprises a pair of crossing units generally designated 200 (Figs. 20A, B and Fig. 30). Each

crossing unit 200 comprising a crossing rail head 50c, planar crossing member or plate 38c, guide flanges 60c, a pair of supporting members 40c, a pair of end plates 72c, and support connecting clip 48c.

The crossing rail head 50c has the same cross sectional shape as that of the switch rail 50, (i.e. upper portion of an I-shaped rail section), and extends diagonally between one end of the crossing unit 200 and the other, so as to point toward the south bound track 12 and thus away from the north bound track 14.

The crossing rail head 50c may span a longer distance along the crossing unit 200 than the crossing plate 38c and the supporting members 40c, thus creating an overhang at either or both ends of the crossing unit 200.

The crossing plate 38c, guide flanges 60c, supporting members 40c, and support connecting clips 48c are broadly similar to those of the switch rail unit 100, and thus require no further description.

The pair of end plates 72c protrude vertically downward from the overhang created by the crossing rail head 50c. Each end plate butts against the end of a supporting member 40c.

The end plates 72 of the switch rail head 50, and the end plates 72c of the crossing rail head 50c may be drilled to suit a standard connecting means such as a fishplate, in order to provide a secure connection between each rail head component.

This non-intrusive turnout 10 has an advantage over the previous alternative non-intrusive turnout 10 of having additional support to the turnout track which is provided by the supporting members 40, 40c whilst still allowing the switch rail head 50, crossing rail 50c, plate 38, and crossing plate 38c to be removed and installed relatively easily, without permanent alteration (i.e. cutting) of the existing track.

Fig. 21A and B show an alternative version of the crossing unit of a non-intrusive turnout, which will now be described.

A partially supported crossing unit generally designated 300 comprises a crossing rail head 50d, and a tapered supporting member 40d.

The crossing rail head 50d is broadly similar to that previously described e.g. 50c and thus requires no further description.

The tapered supporting member 40d is wedge shaped such that it fits in the gap created between the crossing rail 50d and the existing rail near the point of crossing over.

For each previously described non-intrusive turnout 10, when the ramp rails 21, 22, switch rails 23, 24, and crossing rails 29, 30 are removed it is preferable that the end of each gutt rail 25, 26 exposed to an oncoming train is provided with deflecting means which deflect any loose items (not shown) suspended below the railway carriage (not shown) away from the gutt rails 25, 26, thereby preventing such items from snagging on the gutt rails 25, 26 which could otherwise result in derailment of the railway carriage. Figs. 21A, B, C and D show possible deflecting means for this purpose. Each deflecting means is adapted to be easily fitted onto the exposed end of the gutt rails 25, 26 by suitable means, for example a fishplate. Prior to re-installation of the ramp rails 21, 22, switch rails 23, 24, and crossing rails 29, 30, the deflecting means will be removed.

Fig. 23A and B show alternative supporting means for a switch rail and crossing unit of a non-intrusive turnout, which will now be described.

Central level crossing support members 40e known and used in the industry are wedged between the existing rails and are supported by central supports 78c which are connected to the existing sleeper 79. The central level crossing support members 40e are complimented by outer level crossing support members 400e which are supported by outer supports 78o. Positioned between the outer level crossing support members 400e and the inner level crossing support

members 40e are outer packing wedges 120 and inner packing wedges 121. The outer and inner packing members 120, 121 secure the level crossing members 40e, 400e in both the lateral and vertical directions.

The switch rail head 50e and planar member 38e are broadly similar to that described previously (Fig. 19) and are situated above the level crossing support members 40e and 400e.

A similar adaptation is shown in Figs. 23C and D making use of the level crossing supports 40e and 400e in the crossing rail unit.

This support arrangement has the advantage over the support arrangements previously described in that it allows the loads exerted by the passing train to be transferred directly to the sleeper and existing rail, whilst using currently available components.

However, it would be beneficial to reduce the height of certain portions of the raised track surface, specifically those portions which are intended to remain in place between the pair or existing rails in order to ensure that trains which pass along the existing rails during normal running do not collide with the raised track surface.

Referring to Figs. 36a, 36b, 36c, 36f, 37a, 37b, 37c, 38a, and 38b a first embodiment of non intrusive crossover apparatus 500 (Fig. 38a) in

accordance with the first, second and third aspects of the present invention will now be described.

The sequence of rail components length wise along the track of the turnout of Figs. 19 to 35 is the similar to that previously described with the important difference of providing additional ramp sections along the length of the crossover in order to vary the height of the wheels as they are crossing the railway tracks. From the left hand end of the left hand turnout track 516L, a pair of ramp rails 522L, 522r are followed by a pair of switch rails 524L, 524r which have downwardly sloped ramp portions 600 followed by a pair of gutt rails 525L, 525r which are at a lower height (typically a maximum of 25mm above the uppermost surface of existing rails 514 or 512) than the raised portions which pass over the existing rails 514L, 514r. Up until this point the right hand turnout track 516r is substantially the same as the left hand turnout track 516L. At this point the right hand turnout track 516r then joins with upwardly sloped ramp portion 602 of crossing unit 530r which rises to the height required in order to cross the existing track 514L which is typically 50mm above the uppermost surface of existing rails 514 or 512. In order to avoid a discrepancy between the height of the raised track surface on the left hand side and that on the right hand side it is necessary to provide compensation ramps 604 on the left hand raised track surface. At this point the crossover repeats this process in a mirror image to that described in order

to return the raised track to the opposite side of the railway tracks 512l, 512r. The profile of this undulation in height is illustrated by Fig. 38b.

The means of connecting the ramp rails 522L, 522r (G-clamp mechanism 32, represented by 32 in Fig. 26) in this embodiment are broadly similar to that of the previous described non-intrusive turnout, and thus requires no further description. However, an alternative embodiment of the ramp rails in accordance with the third aspect of the present invention will be described subsequently.

Following on from the ramp rails 522L, 522r, Figs 37a, 37b and 37c show a switch rail unit generally designated 524 comprising a switch rail head 550, planar support member or support plate 538, guide means 560 in the form of downwardly projecting guide flanges 560, a pair of supporting members 540, end plate 572, and support connecting means 548 in the form of clips 548.

The switch rail head 550 essentially takes the form of an upper portion of an I-shaped rail section and extends between one end of the switch rail unit 524 and the other. The switch rail head 550 is inwardly curved along its length toward the south bound rail track 512 and thus away from the north bound rail track 514, in a broadly similar manner to the that previously described (Fig. 1). The switch rail head 550 has a downwardly sloped portion 600 at the end of the unit 524.

The planar support member or support plate 538, guide flanges 560, support members 540, clips 548 and end plates 572 are substantially identical to that previously described and therefore will not be described further.

Following on from the switch rail unit 524 the turnout next comprises a pair of gutt rails 525L, 525r. The gutt rails 525L, 525r are located at a height and location which coincides with the lower end of the downwardly sloped portion 600 of the switch unit 524.

On the right hand turnout rail 516r, following on from the gutt rails 525r the turnout next comprises a crossing unit generally designated 530 (Figs. 36a, 36b, 37c). Each crossing unit 530 comprising a crossing rail head 550c, planar crossing member or plate 538c, guide flanges 560c, a pair of supporting members 540c, a pair of end plates 572c, and support connecting clip 548c.

The planar member or plate 538c, guide flanges 560c, support members 540c, clips 548c and end plates 572c are substantially identical to that previously described and therefore will not be described further.

The provision of the ramp rails 522L, 522r, switch rail 524L, 524r, downwardly sloped ramped portion 600, gut rails 525L, 525r, crossing unit 530r and compensation ramps 604 of the turnout section

provides, when connected to another oppositely arranged turnout section, a raised surface which allows the train to travel from the first railway track 514 to the second railway track 512 as follows:-

The wheels are firstly raised (by about 50mm) by ramps 522L, 522r onto switch rails 524L, 524r which moves the wheels (and hence the train) away from the existing rails 514L, 514r. This effectively allows the flange of the wheel running along the left hand rail to pass over the left hand existing rail 514L;

Ramp portions 600 then lower (by approximately 25mm) the wheels onto gutt rails 516L, 516r which transport the wheels further from the existing rails 514L, 514r;

The wheels are then raised (by about 25mm) back up to the height which is substantially the same height as that at which the left hand wheel previously crossed the existing rail 514L. This now has the effect of allowing the flange of the right hand wheel to pass over the left hand existing rail 514L.

The wheels then continue until the left hand wheel passes over existing rail 512r;

The wheels are then lowered (by about 25mm) on ramp portions equivalent to 600 on the opposite end of the non intrusive crossover section;

The wheels are then brought toward the second railway tracks 512L, 512R by gutt rails 542L, 542r; The wheels are then raised again (by about 25mm) via ramp portions 600B such that the flange of the right

hand wheel running along the right hand gutt rail 542r may pass over existing rail 512r; and

the wheels are finally lowered (by about 50mm) onto existing track 5121 and 512r by ramp portions 523L and 523r.

Referring to Figs. 36e and 37e an embodiment of non intrusive crossover in accordance with a second aspect of the present invention will now be described.

In this embodiment essentially the same switch apparatus is provided as previously described for the first embodiment with the important difference that a hinging mechanism 700 is provided in order to hinge the planar plate 1538 and the switch rail 1550 away from the supporting members 1540 when normal running is desired; in other words the planar plate 1538 can be rotated about the hinge mechanism 700 from a first configuration in which the turnout is in operation to a second configuration in which the planar plate 1538 is clear of the existing rails and thus normal running of trains on the existing rails can occur. In the same way, hinging means 700 may be provided on the crossover apparatus in order to hinge the planar plate 1538c and the crossover rail 1550c away from the supporting members 1540c when normal running is desired.

Referring to Figs. 39a, 39b, 39c and 39d an embodiment of the ramp apparatus in accordance with

a third aspect of the present invention will now be described.

The ramp apparatus generally designated 522 is secured to the outer edge of an existing rail 514 and which is thus arranged on one side thereof by clamps 576 in a similar manner as that previously described. The ramp comprises a sloped portion 513 and a levelled portion 515 which are integrally formed on a single member and which provide a rail surface for a tread of the wheels to traverse. The sloped portion 513 is provided with an introductory or lead-in slope 517 which extends below the level of the existing rail 514 on its outer edge. As shown in Fig. 39b, the sloped portion 513 is tapered to as low a height as possible (such as 10mm or so) where it abuts against the upper surface of the existing rail 514, though it will be appreciated by the skilled reader that it is not possible to have no height at the end of the taper especially since such a thin area would be liable to succumb to damage due to the train passing over it. In order to mitigate this problem in addition to being tapered with respect to height, the tapered end of the sloped portion 513 is also angularly tapered over the surface of the existing rail 514.

It will be understood by those skilled in the art that train wheels 507 generally have a slightly greater width than the rails on which they are designed to run and therefore an overhang portion (in the order of a few mm) is created (not shown)

where the outer edge of the wheel tread 509 does not come into contact with the existing track 514 surface.

In operation, as the wheels 507 of the train pass along the existing rail 514 and toward the ramp 522 the overhang portion on the wheels 507 will be gradually introduced to the ramp by the introductory slope 517. Thus when the rest of tread 509 of the wheel abuts against the taper of the sloped portion 513 there will be a smooth transition from the existing rail 514 to the slope 513 and on towards the levelled portion 515. This is beneficial since it minimises the damage to the tapered portion of the ramp 522.

It should be noted that the embodiments of the invention described allow a train to be transferred from a first railway track to a second railway track without permanently damaging either the first or second railway tracks, and that the invention described allows particular sections of the non-intrusive crossover section to be left in position during normal running of the track i.e. when it is not desired to transfer the train from the first to the second track. The embodiments described also allow those sections to be left in place without contravening specific requirements relating to the height (such as 25mm) which components protrude above the ground during normal running.

Modifications and improvements may be made to the embodiments described herein without departing from the scope of the invention.